IRAM-France Day

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Website: https://iram-france.sciencesconf.org/
Abstract booklet: https://iram-france.sciencesconf.org/data/pages/iram_france_program.pdf
Presentation slides: https://iram-france.sciencesconf.org/data/pages/iram_france_slides_public.pdf

Abstract

Both IRAM observatories (the NOEMA interferometer and the IRAM-30m single-dish telescope) are undergoing significant development of their observing capacities. In addition to being worldwide centers of expertise for (sub-)millimeter radio-astronomy, IRAM observatories offer a useful complementarity with ALMA in terms of angular resolution and wavelength. Another strength of IRAM is responsiveness: as a smaller integrated facility that serves a restricted community, IRAM assists users to fine-tune their programs to optimize the science return and continually works to reduce the delay between an observation request and data delivery.

In the framework of the INSU-AA 5-year prospective exercise, a one-day event was organized to highlight future French scientific projects for each IRAM observatory, and to reinforce the link between IRAM and the French astronomy community. Ideas for facilitating French PI-ship of flagship Large Programs (LPs) were discussed. For instance, the absence of a flexible, reactive funding instrument in France to support the recruitment of PhDs and postdocs on LPs was identified as a significant barrier to progress. INSU could consider the possibility to inject dedicated PhD/postdoc positions to accompany the exploitation of accepted French-led LPs. The creation of PhD student observational projects at IRAM, involving several tens of hours per semester spread over a few years and with intermediate status between standard and large programs, would be a constructive mechanism to foster expertise in (sub-)millimeter astronomy.

Introduction

This note summarizes the discussions that took place at the IRAM-France day. The day attracted more than 90 participants. There were many discussions that 1) highlighted future scientific projects that would benefit from the tremendous increase in IRAM's capabilities, and 2) reinforced the link between IRAM and the French community. This day was also an excellent opportunity to reiterate the support of the French community to IRAM, in the context of the on-going science pluri-annual strategic planning of the INSU Astronomy . It is beyond the scope of this note to discuss the science that was presented during the day. The presentations can be found on the website.

IRAM develops two (sub-)millimeter observatories: an interferometer in the French Alps and a 30m single-dish in the Sierra Nevada in Spain. The capability of these observatories has increased many fold over the last decade, and it will still increase in the coming decade.

NOEMA

The NOEMA project, which started in 2011, involves 1) doubling the number of 15m antennas (from 6 to 12); 2) increasing the instantaneous bandwidth from 8 to 32 GHz; 3) developing a new correlator that simultaneously covers the full 32 GHz bandwidth at 2 MHz resolution and a quarter of this bandwidth at 62.5 kHz resolution with a system of 128 flexible windows of 64 MHz bandwidth; and 4) extending the largest baseline from 0.8 to 1.7 km. The total cost is 50 Meuros.

NOEMA Phase I (10 equipped antennas and the correlator for 12 antennas) finished on February 1st 2019. Funds for NOEMA Phase II (two additional antennas and the baseline extension) became available end of 2018. The full project should be completed in 2021. At this point, NOEMA will provide a point source sensitivity that is equivalent to 65% of ALMA's for continuum and spectral-scan surveys, and 45% of ALMA's point source sensitivity for single spectral line observations.

Several development steps beyond NOEMA Phase II are already funded by asymmetric investment: 1) full phasing for millimeter VLBI is funded through the ERC Black Hole camera; and 2) the dual band extension (including the doubling of the correlator power) is funded through the Max Planck Gessellschaft. Stokes polarimetry (in the time domain) is foreseen but not yet funded.

Current and future projects for the IRAM 30m telescope

At Pico Veleta, the 30m telescope was first equipped with the current generation of broad band spectrometer receivers in 2009. This system, named EMIR, has been upgraded several times to prototype the development required for the NOEMA project, e.g., the increase of bandwidth from 70 to 80 GHz. Dual band capability is already in place. At the same time, the NIKA2 dual band continuum camera with a 6 arcminute field of view was installed. The commissioning of its polarimetry capability at 1 mm has begun. The NIKA2 camera was developed and largely funded by a French-led consortium rewarded via a Guaranteed Time scheme. IRAM develops two multi-beam heterodyne arrays: one with 50 pixels at 3 mm and one with 98 pixels at 1.3 mm. Each pixel will have at least the same instantaneous bandwidth coverage as EMIR, i.e., 16 GHz per polarization.

IRAM is preparing an ambitious program to upgrade the 30m telescope. This upgrade is motivated by 1) the importance of large-scale mapping and surveys, 2) the importance of low surface brightness astronomy, 3) the importance of increasing the calibration accuracy in the millimeter domain, 4) the multi-million euro effort put into powerful mapping instruments, and 5) the fact that the 30m is an integral part of the NOEMA concept as it provides the short spacings required by wide-field imaging. The upgrade will include the improvement of the surface with the goal to achieve 40 micro-meter rms for an elevation between 15 and 85 degrees, an improved thermal control of the primary surface, and a replacement of the drive system and control loop.

IRAM, a center of expertise for (sub-)millimeter radio-astronomy

The current agreement between France, Germany, and Spain expires in 2024. A ten year extension to this agreement is currently in preparation. The IRAM annual budget is about 15 Meuros (including temporary external funding). This includes staff salary for approximately 75 persons at the Grenoble headquarters, and 50 persons to run both observatories (Pico Veleta and Bure).

IRAM constitutes a world-class center of expertise for (sub-)millimeter radio-astronomy. IRAM assembles the NOEMA antennas at Bure. It builds its receivers (optics, mixers, SIS junction, electronics) and correlators. In both cases, it develops the associated control software. It acquires, calibrates, and archives the data. This includes the development of the data reduction software. IRAM conducts research and development. For instance, IRAM is working on the next generation of heterodyne receivers that double once again the amount of available intermediate frequency (from 16 to 32 GHz per polarization).

The IRAM observatories have an extremely flexible instrumentation suite. As at any observatory, this implies some complexity in their use. However, IRAM is committed to support all astronomers, whatever their background in millimeter radio-astronomy, from proposal submission to data reduction. While not always well known outside the radio-astronomy community, this is a long standing working service. For NOEMA, potential PIs can email the Science Operation Group (mailto: sog@iram.fr) to present their ideas and receive support in designing the technical aspects of their proposals. After the observations, an automatic calibration pipeline successfully delivers high quality calibrated visibilities. and constant work is made to ease the imaging and deconvolution part. In addition, IRAM local contacts provide face-to-face support to astronomers visiting Grenoble to reduce their project's data. At the 30m, a full NIKA2 science pipeline is still lagging (delaying the nominal use of the instrument by the community). Finally, IRAM hosts the French ALMA arc node.

Calls for proposals, standard and large observing programs

There are two calls for proposals per year, with deadlines in mid-March and mid-September. Large programs that require more than 100 hours may be proposed at a single deadline, and programmed over up to 8 semesters. The PI of a large programs must belong to one of the partner countries. A PI of an accepted large program cannot propose standard programs as PI while the observations of the large program are on-going. This is to ensure the science success of large programs. Officially, up to 50% of the total IRAM observing time can be made available for large programs. To date, typically between 20 and 30% of observing time has been invested in large programs. IRAM suspended the possibility to propose large programs at Bure from the end of 2014 to mid-2018 due to the large increase of capability delivered by the NOEMA correlator.

Any program under 100 hours is considered as a standard program. Programs of 70-80 hours are regularly accepted, even though the science requirements are more demanding than for smaller projects. PhD student projects (several tens of hours per semester over 2 or 3 years) would be an interesting intermediate program status between standard and large programs. All observed projects, including Guaranteed Time ones, are examined by the program committee to ensure that the best science is achieved. Guaranteed Time and Large Program sources are fenced to avoid duplicate observations by standard programs. This currently implies that all sources need to be defined at submission. An evolution of this scheme is requested to allow PIs to request observations of sources that will be detected in the framework of another project, for instance, follow-ups at NOEMA of targets detected in a given field-of-view with NIKA2.
The IRAM direction encouraged the French community to be more active in leading medium and large programs (see last paragraph on forces and weaknesses of the community). There was also the question of legacy surveys (directly made public to all astronomers at the time the data is acquired) that would increase IRAM's international visibility but the benefits to the French community were not clear.

Observing time allocation

The distribution of IRAM observing time evolves over time to account for external and/or asymmetric investments. These investments enable IRAM to improve its capacity, thus increasing the astronomical value of each observed hour. In 2019, the goal set by the IRAM Steering Committee for the IRAM-30m time distribution is as follows: 28.56% for each of France and Germany, 10.88% for Spain, 10% for IRAM staff, 7% of guaranteed time for one-time contributors (University of Michigan, Purple Mountain Observatory, Nanjing University, and a deal with University of Wisconsin is in preparation), and 15% for the worldwide open sky policy. The goal for the NOEMA observing time allocation between partners is slightly different to take into account that Spain did not contribute to funding the NOEMA project: 30.6% for each of France and Germany, 6.8% for Spain. In these statistics, only the institute of the PI is taken into account. Both accepted (A-rated) and backup (B-rated) projects are counted. The IRAM Steering Committee monitors that these shares are respected, after averaging the actual time allocations over a few years.
Note that the French-led NIKA2 consortium has been allocated 1,200 hours of IRAM-30m guaranteed time over 4 years. In the coming years, the Max Planck community will be allocated additional hours of NOEMA guaranteed time to take into account their asymmetric investment for the baseline track extension and dual band correlator. The exact amount of guaranteed time is still being discussed.

Archive

The header information of all observations is made available to the CDS about 12 months after the observations are taken. Several thousands of unique requests to this service are made every year. The data are made available to PIs as soon as observed. The propriety period is 36 months for standard programs. The propriety period for large programs is 18 months, starting at the end of the last semester of observations. All observations are kept indefinitely in raw data format and (pipeline) calibrated data format. Two copies are kept for NOEMA. Only one copy is currently kept for 30m but a second copy will be installed in the near future. Requests for data of standard programs can be made through IRAM without contacting the PI and will be served unless data have special flags (for instance, data required for a PhD thesis project). IRAM nevertheless does not have the manpower to help reducing anew the data.

The consortium running a large program must deliver the reduced data products to the community after the end of the propriety period. These data are available on the IRAM web page (see http://www.iram-institute.org/EN/content-page-386-7-386-0-0-0.html and http://www.iram-institute.org/EN/content-page-351-7-158-351-0-0.html). The IRAM French community notes that there is currently no possibility to browse data cube products, as offered by the ALMA archive. This would be useful to help understand whether available observations are useful for a particular science purpose. Establishing this service would have non-negligible processing, storage, and access costs, which are not currently funded.

NOEMA vs ALMA

NOEMA and ALMA are complementary facilities: the NOEMA sweet spot corresponds to millimeter observations at 0.5-3" resolution, while ALMA's sweet spot is in (sub)-millimeter observations at 0.01-0.1". Being a smaller integrated facility that serves a restricted community, IRAM can help its users to fine-tune their programs to optimize the science return. Furthermore, it continually tries to improve its flexibility to reduce the time between the observational request and delivery of the data. For the French community, the oversubscription at IRAM is lower than for ALMA. The IRAM observatory is thus an excellent asset to leverage ALMA data.

Strengths and weaknesses of the French community

While the French IRAM community is often a front-runner in testing innovative ideas and pushing IRAM instruments to the limit of their technical capacities, IRAM notes that the French IRAM community is typically less focused on how to optimize observational programs to an instrument's performance to maximise the science throughput. The French IRAM community is well-connected in international collaborations and networks, but there is room for further progress, in particular in leadership. On average, the French community tends to work in smaller groups and thus so far has been less active in large program area. On average, the time lapse between data delivery and publication is slightly longer for the French IRAM community. The last two points might be related to number of available PhD and post-doc positions in France. IRAM has and will continue to support funding requests from IRAM users to national or European funding agencies (e.g. letters of support), as long as there is no conflict of interest with IRAM and its partners. The quantity and the complexity of the observational data from IRAM is such that many different fields of expertise (including the articulation between observations and numerical simulations) are required, both at the proposal stage and during data analysis. Compared to other systems (e.g., the American one), it was noted that France has no simple way to obtain funds to hire PhD-students and post-docs once a large program is accepted. On the other hand, France has many permanent positions that allows us to build strong lasting teams, as demonstrated by the Herschel legacy programs and the Planck survey. The importance of building such teams to lead large programs in ground-based (sub)-millimeter astronomy was highlighted, since large observational programs are increasingly recognized as a driving force in the advancement of a scientific field. With access to IRAM instruments, the French community continues to have unique opportunities to make significant contributions in the field of (sub-)millimeter astronomy.